Hall Magnetometry on a Single Iron Nanoparticle I

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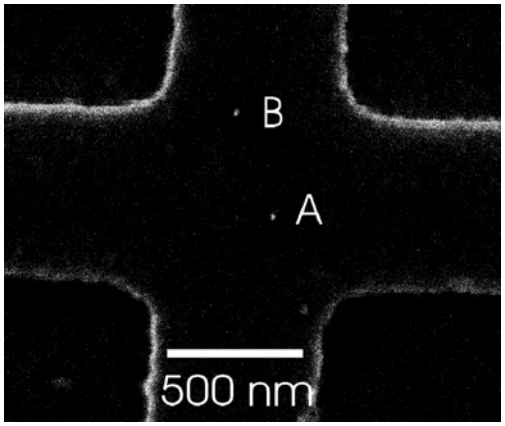
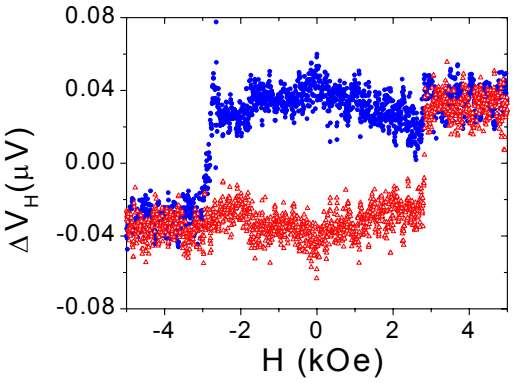
The measurement of magnetic properties on the nanometer scale is of fundamental importance as well as technological relevance in magnetic sensing and information storage. In contrast to magnetic force or scanning tunneling microscopies and low temperature SQUID techniques, Hall magnetometry offers methods for measuring individual nanometer scale magnetic units at high sensitivities and in a non-invasive manner over wide temperature and magnetic field ranges. Although high sensitivities for this method have been predicted, our measurements are the first to demonstrate sensitivities approaching 10^5 electron spins. This high sensitivity magnetometry over a wide temperature range (up to 75K) has been achieved using submicron GaAs/GaAlAs Hall gradiometry. We are currently extending the technique to room temperature where we expect it to have applications in spintronic devices and biosystmes.



Scanning electron micrograph of the Hall device upon which rest three magnetic particles of diameter ~ 5 nm. Only particle A toward the center of the Hall cross provides a magnetic signal because of geometric and edge depletion effects.



The figure above shows the Hall voltage response in the form of a magnetic hysteresis of particle A having magnetic moment $m = 5\times10^5\ \mu_B$.

Li et al. Appl. Phys. Lett. **80**, 4644 (2002).

Hall Magnetometry on a Single Iron Nanoparticle II

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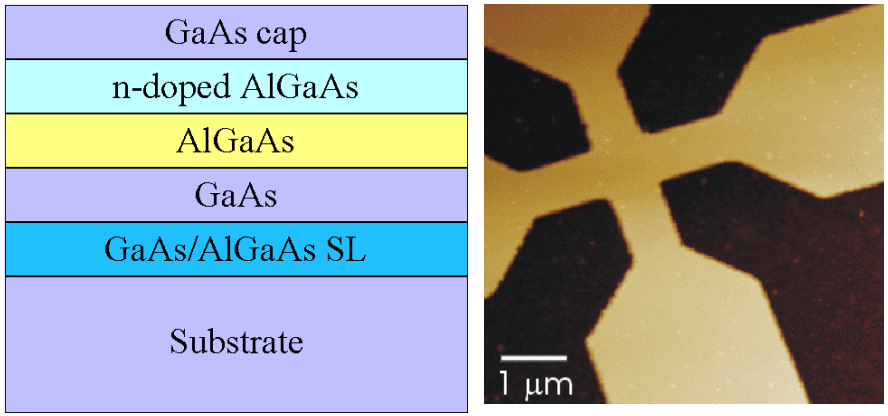
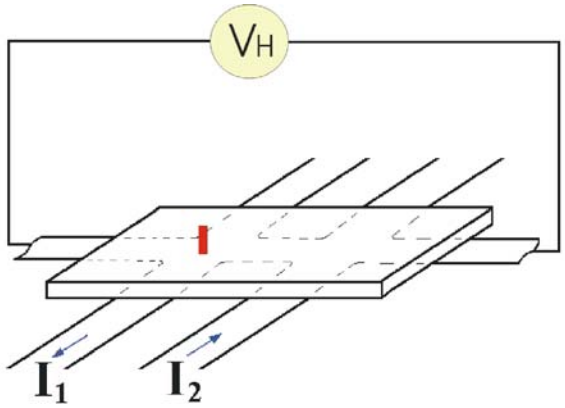
This project requires a complement of skills including nanofabrication and sophisticated measurement techniques. Currently the Hall magnetometry project involves several disciplines at Florida State as well as faculty from several departments at UC Santa Barbara, and Tohoku University, Japan, (Physics, Engineering and Biology). At least two postdoctoral fellows and a number of graduate students have been exposed to these interdisciplinary activities.

We have also developed new facilities including e-beam/focused ion beam lithography and a small clean room which houses photolithography, reactive ion etching, and a bonder. These facilities have been made available to both graduate and undergraduate students.

The PI, in addition to advising graduate students and postdoctoral fellows, also gives several lectures a year on nanofabrication and metrology to graduate and undergraduate audiences.





Schematic of semiconductor device geometry and gradiometer circuit for Hall magnetometry with one particle in place